Basewide Energy Systems Plan for Harry Diamond Laboratories

Volume I

Executive Summary

Final Report

Prepared for:

U.S. Army Corps of Engineers

Norfolk District

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August 1983

BASEWIDE ENERGY SYSTEMS PLAN

FOR

HARRY DIAMOND LABORATORIES

ADDRESSING INCREMENTS A, B, C, F AND G

VOLUME I

EXECUTIVE SUMMARY

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Replace Mercury Vapor High Bay Lighting System
Site Lighting

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Install Thermostatic Control Valves
Install Ceiling Insulation
Reduce Temperature Stratification in High Bay Areas
Install Automatic Condenser Brush Cleaners

EXECUTIVE SUMMARY

This report presents the final results of Increments A, B, C, F and G of the Basewide Energy Systems Plan for Harry Diamond Laboratories (HDL), in Adelphi, Maryland prepared by JRB Associates (JRB) under Contract No. DACA65-80-C-0015. The report includes analyses of the energy use patterns at the base and the identification and evaluation of energy conservation opportunities. The obtained results indicate that HDL energy use can potentially be reduced by 29.6 percent by FY 1985, compared to the FY 1978 energy use baseline.

The report is organized into three volumes: Volume I - Executive Summary, Volume II - Main Report, Facilities Engineer Conservation Measures, and Solar Wind Analyses, and Volume III - Appendices and ECIP projects.

The Main Report is organized into four sections:

- Section 1. Describes the HDL facility and discusses the scope of the energy conservation study.
- Section 2. Provides an overview of energy use at HDL for FY 1979 and a fuel use profile for the past three years.
- Section 3. Contains JRB's analyses of the HDL energy supply and distribution systemm.
- Section 4. Contains the results of JRB's analyses of potential energy conservation projects, and discusses the methods employed to determine project costs and energy savings.

Information for the study was obtained during a series of site visits which encompassed the Adelphi, Woodbridge and Blossom Point facilities. A summary of the HDL building inventory is shown in Table 1. The summary of energy use over the past three years in Table 2 indicates that total energy use at HDL has been relatively unchanged from FY 1977. However, the facility has developed considerably since FY 1975 with significant increases in its basic mission. This fact has necessitated the designation of FY 1978 as the baseline year for energy record purposes.

TABLE 1. HARRY DIAMOND LABORATORIES - BUILDING ENERGY USE SUMMARY

BUILDING No. & FUNCTIONAL USE	TOTAL FLOOR AREA SQUARE FEET	TOTAL ENERGY USE IN FY 1979 - Btu x 10^9	ENERGY USE IN Btu/GSF/YEAR
101 Motor Pool Shop	5,888	4.097	695,822
102 Supply Center	28,835	8.583	297,659
103 Engineering	16,016	6.516	406,843
202 Laboratory	167,220	73.229	437,920
203 Laboratory	181,829	61.721	399,445
204 Office/Laboratory	167,220	124.444	744,282
205 Office/Cafeteria	111,250	53.091	477,222
500 Laboratory	40,850	36.134	884,553

NOTE: The above are the major buildngs at the site.

TABLE 2. ENERGY USE AT HARRY DIAMOND LABORATORIES FY 1977 to FY 1982

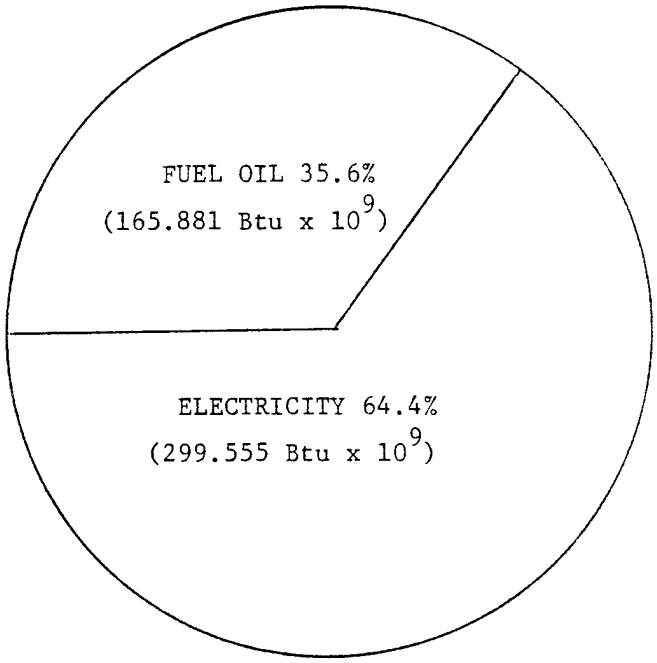
FUEL TYPE	FY 1977 $_9$ Btu x 10^9	FY 1978 $_9$ Btu x 10^9	FY 1979 $_9$ Btu x 10^9	FY 1980 $_9$ Btu x 10^9	FY 1981 $_9$ Btu x 10^9	FY 1982 $_9$ Btu x 10^9
FUEL OIL	175.717	190.641	165.881	128.973	146.760	108.140
ELECTICITY	290.459	298.627	299.555	300.474	317.840	347.327
TOTAL	466.176	489.268	465.436	429.447	464.600	455.467

Figure 1 illustrates the total energy use in buildings at HDL by fuel type. Fuel oil accounts for approximately 35 percent of the total, while electricity accounts for over 64 percent. The high electrical use reflects the preponderance of energy intensive research and development activities at the facility. Peak fuel oil use occurs during the winter months as a result of the demand for building heat. The demand for electricity peaks during the summer, reflecting the extensive use of electrically-driven air conditioning equipment.

The control heating system was examined in detail. The central plant at the Adelphi site provides high temperature water to the majority of buildings through an underground system of insulated pipes. The Woodbridge site is heated through underground steam lines, many of which were found to be in poor condition. The central plant at Aldelphi also supplies chilled water for cooling purposes which is generated by electrically-driven centrifugal chillers. Boiler inefficiencies and distribution losses account for 30 percent of the total fuel oil use at HDL. A boiler plant modification program planned for FY 1982 will reduce some of these losses. A breakdown of HDL fuel oil energy use is shown in Figure 2.

A similar analysis was performed for the electrical system. The highest electrical energy use is for research and development equipment, amounting to nearly 42 percent of the total. Over 40 percent of the base electrical energy use is accounted for by building cooling requirements, and by the operation of circulating fans and pumps. Losses in the electrical system are only 3 percent. The electrical energy use profile for HDL is shown in Figure 3.

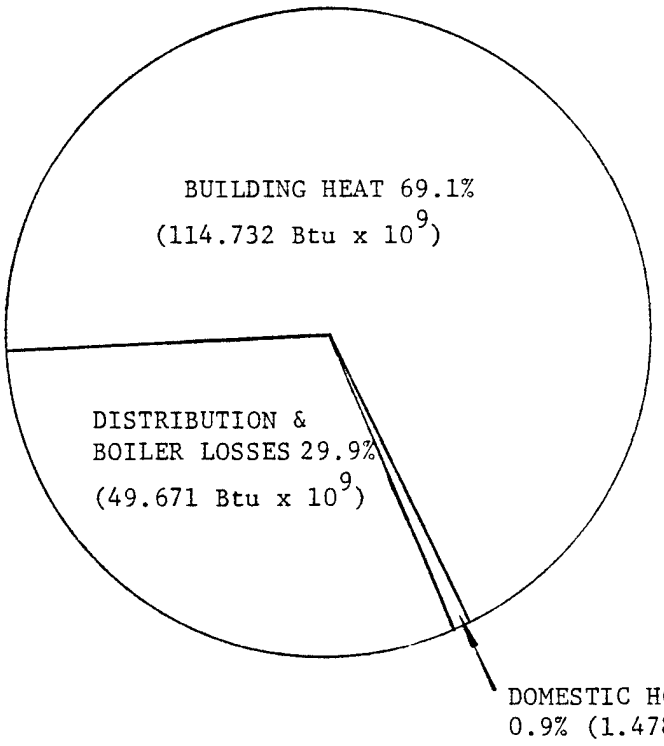
The programmed Energy Conservation Investment Program (ECIP) projects at HDL include the installation of an Energy Management Control System (EMCS) which is to be installed during FY 1984, and modifications to the boiler plant. Additional energy conservation opportunities were developed by JRB Associates, and were analyzed for their engineering and economic feasibility. Table 3 shows the energy conservation measures examined while Table 4 provides the list of recommended ECIP projects. The results of these analyses are presented in Section 4.3 of the Main Report. JRB also identified various



TOTAL ENERGY USE AT HDL FY 1979 — 465.436 Btu x 10^9 per year

NOTE: PROPANE IS NOT SHOWN, SINCE THE AMOUNT USED IS INSIGNIFICANT.

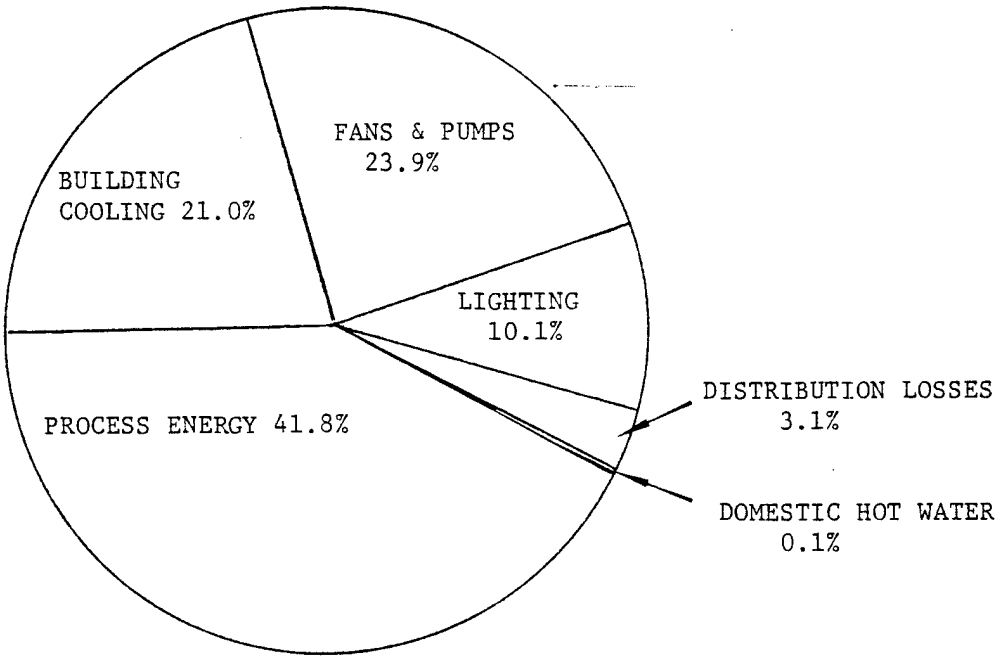
FIGURE 1. TOTAL ENERGY USE IN BUILDINGS BY FUEL TYPE, FY 1979
HARRY DIAMOND LABORATORIES



TOTAL FUEL OIL ENERGY USE — 165.881 Btu x 10^9 per year

FIGURE 2. FUEL OIL END USE PROFILE, HARRY DIAMOND LABORATORIES (FY 1979)

Figure 3 goes here



TOTAL ON-SITE ELECTRICITY USE FY 1979 - 25,823,675 kWh per year

FIGURE 3. ELECTRICAL ENERGY END USE PROFILE AT HARRY DIAMOND LABORATORIES (FY 1979)

TABLE 3. POTENTIAL ENERGY CONSERVATION OPPORTUNITIES

OPTION DESCRIPTION	E/C	B/C	ENERGY SAVINGS MBtu/Yr	CWE ($)	ANNUAL SAVINGS ($)	PAYBACK (YRS)	STATUS
CENTRAL HEATING/COOLING PLANTS							
Boiler Economizer							N/A
Boiler Water Treatment							N/A
Variable Speed Chiller Motor							N/A
Return Condensate							N/A
Insulate Pipes							N/A
Add Flue Dampers (Oil Furnaces)							N/A
Automatic Condenser Cleaning	20.1	1.8	4,594.0	228,865	13,827	7.2	O&M
Refuse Derived Fuels							N/A
EMCS							PROG.
BUILDING SHELL							
Reduce Window Openings							N/A
Storm Windows	4.7	1.1	0	0	0	20.4	NO
Wall Insulation (interior)	4.7	1.1	25.5	5,337	261	20	NO
Roof Insulation	9.5	2.3	188.0	19,769	1,957	3.4	O&M
Loading Dock Door Seals							N/A
Reduce Solar Heat Gain							N/A
Vestibules	0.7	0.1	3.2	4,766	30	156	NO
Wall Insulation (exterior)	2.9	0.7	255.0	88,805	2,607	34	NO
Reduce Door Size							N/A
Loading Dock Strip Doors	21.4	2.0	39.7	1,854	370	5	O&M
Replace Windows	3.7	0.9				26	NO
LIGHTING							
Replace Mercury Vapor in Bldg. 203 & 500	21.6	2.9	2,343.0	108,396	14,105	7.2	ECIP
Use Higher Efficient Ballasts	8.1	0.8	0.6	74	4	17.6	NO
Reduce Heat of Luminaires							N/A
Add Switching							N/A
Use Automatic Dimming Controls	16.7	1.7	4,337	258,871	21,448	12.1	ECIP
Site Lighting	20.9	2.6	1,901	90,767	11,634	7.8	ECIP
Replace Incandescent							N/A
Exit Lights							N/A

TABLE 3. POTENTIAL ENERGY CONSERVATION OPPORTUNITIES
(CONTINUED)

OPTION DESCRIPTION	E/C	B/C	ENERGY SAVINGS MBtu/Yr	CWE ($)	ANNUAL SAVINGS ($)	PAYBACK (YRS)	STATUS
BUILDING HEATING AND COOLING							
Eliminate Unnecessary Roof Vents							N/A
Reduce Air Flow Rates							N/A
Shut Down Ventilation Systems							PROG.
Spot Cooling and Heat Wheels for Recovery	14.7	2.1	4,581.0	311,373	27,965	11.1	ECIP
Temperature Setback							PROG.
Warm-up Cycle Controls							PROG.
Automatic Control Valves for Radiators	59.2	9.1	603.0	10,244	6,532	1.6	O&M
HVAC Controls Rezone Heating System	99.6	9.8	24,537.0	246,230	174,994	1.4	ECIP
Economizer Controls							N/A
VAV Systems							N/A
Shut Down Air Conditioning Systems							PROG.
Air Stratification	39.9	6.7	799.7	20,061	9,399	2.1	O&M
Temperature Setback							N/A
EMCS							PROG.
Replace Gas Pilots with/ Spark Ignition							N/A
DOMESTIC HOT WATER							
Use Local Hot Water Heaters							N/A
Solar Heating 120 Panel	5.61	0.7				30.1	NO
3 Panel	2.87	0.4				58.7	NO
Insulation, Hot Water Tanks	4.8	0.9	14.94	3,090		23.7	NO
Boosting Water Temperature							N/A
Shutdown							N/A

TABLE 4. PRIORITIZED LIST OF RECOMMENDED ECIP PROJECTS

Project Title	E/C Ratio	Annual Energy Savings (MBtu)	CWE ($)
HVAC Controls	99.65	24,537	245,230
Site Lighting	20.94	1,901	90,767
High Bay Lighting	21.62	2,343	108,396
Dimming System	16.75	4,337	258,871
Spot Cooling and Heat Wheel	14.71	4,581	311,373
TOTAL		37,699	1,015,637

TABLE 5. SUMMARY OF INCREMENT G PROJECTS

PROJECT	E/C	B/C	EC/CC	PAYBACK (YRS)	FUEL ENERGY SAVINGS OIL (10^6 Btu)	FUEL ENERGY SAVINGS GAS (10^6 Btu)	FUEL ENERGY SAVINGS ELECT. (10^6 Btu)	ANNUAL ENERGY SAVINGS (10^6 Btu)	ANNUAL COST SAVINGS ($)	CWE ($)
Thermostatic Control Valves for Steam Radiators-Woodbridge	85.0	13	19.2	1.1	1,047	-	-	1,047	$11,333	$ 12,314
Air Stratification-Adelphi	9.9	1.8	2.6	8.0	278.8	-	-50.1	228.7	2,850	22,917
Install Automatic Brush Cleaners on Water Cooled Condenser-Adelphi*	20.1	1.8	2.7	7.2	-	-	4,598	4,598	31,865	228,864
Roof Insulation-Adelphi and Woodbridge	9.5	2.3	3.4	10.1	140	-	48	188	1,957	19,769
TOTAL					1,465.8		4,595.9	6,061.7	$48,005	$283,864

*Projects that qualify for ECIP funding

operation and maintenance procedures and projects that could potentially reduce HDL's fixed facilities energy use. The list of projects developed is shown in Table 5 and is presented in Section 4-6 of the Main Report. The projected future energy costs for Adelphi and Woodbridge are presented in Table 6 and 7.

Increment F of the Basewide Energy Systems Plan for HDL evaluated energy conservation projects that can be done under Facility Engineering programs and presents a summary of projects implemented and planned.

Eleven Facility Engineering energy conservation projects were evaluated and are summarized in Table 8. Seven projects, in whole or in part, are recommended for implementation and can save 30 billion Btu/year, reducing post energy use by approximately seven percent. Part of project 9 (low energy winter cooling for building 500) and project 3 (metering chillers) are not recommended due to poor economics. Installation of a small air compressor (project 11) was deemed inapplicable as peak demands could not be met with a smaller compressor. Two of the cost effective Increment F projects are to be accomplished in the proposed EMCS and therefore, are not recommended.

The work involved in Increment C is addressed in Volume II c, and includes the analysis of renewable energy sources - solar and wind.

Four applications for renewable energy are addressed for HDL located at Adelphi and Woodbridge. The four applciations discussed are:

- Solar Domestic Hot Water for Adelphi and Woodbridge
- Solar Applications for Summer Boiler Shutdown, Adelphi
- Solar Project System for the Drying Room, Building 204, Adelphi
- Wind Energy Conversion System at Woodbridge

The analysis discusses the development of energy use profiles, types of systems evaluated, systems performance, wind speed profiles and results of economic analyses.

TABLE 6. FUTURE ENERGY COSTS - ADELPHI SITE

Fuel Type	FY 1980 Average $/Unit	Btu Per Unit	FY 1980 $/MBtu	FY 1981 $/MBtu	FY 1982 $/MBtu	FY 1983 $/MBtu
#2 Oil (Gallons)	.91	138,700 Btu/gal	6.56	7.55	8.68	9.98
Electricity (kWh)	.0459	11,600 Btu/kWh	3.96	4.55	5.24	6.02

TABLE 7. FUTURE ENERGY COSTS - WOODBRIDGE SITE

Fuel Type	FY 1980 Average $/Unit	Btu Per Unit	FY 1980 $/MBtu	FY 1981 $/MBtu	FY 1982 $/MBtu	FY 1983 $/MBtu
#2 Oil (Gallons)	.86	138,700 Btu/gal	6.20	7.13	8.20	9.44
Electricity (kWh)	.052	11,600 Btu/kWh	4.48	5.16	5.93	6.81

TABLE 8. HDL INCREMENT F PRIORITIZED PROJECT SUMMARY

PROJECT	IMPLEMENTATION COSTS	COST SAVINGS	ENERGY SAVINGS MBTU/YEAR	SIR	MANHOURS TO IMPLEMENT
2.6 Install Local Control on Fume Hoods	$ 400	$ 23,400	4,360	907	7
2.5 Revise Air Conditioning Systems in New Office Areas	$ 1,000	$ 20,000	3,673	258	Air Balance Contractor
2.1 Evaluate Building 204 Exhaust Air System	$ 11,000	$ 11,400	2,152	14.0	142
2.4 Use Programmed Chiller Controls	FUNCTION PERFORMED BY EMCS UNDER DESIGN				
2.2 Reduce Domestic Hot Water Temperature, Building 205	$ 4,400	$ 900	157	3.0	12
2.8 Install Electrical Load Shedding Equipment	FUNCTION PERFORMED BY EMCS UNDER DESIGN				
2.7 Install Electronic Controller on Large Motors	$ 537,700	$ 89,900	17,488	2.1	352
2.10 Steam and Condensate Distribution System - Woodbridge	$ 3,300	$ 300	34	1.0	46
2.9 Low Energy Winter Cooling System :					
Building 106	$ 104,600	$ 9,200	2,160	1.1	789
Building 500	$ 56,400*	$ 2,100*	607*	0.5	436
2.11 Evaluate Smaller Air Compressor	N/A	NOT APPLICABLE			
2.3 Meter Chillers - Building 106	FUNCTION PERFORMED BY EMCS UNDER DESIGN				
TOTALS	$717,100	$ 157,200	30,631		

*Not included in totals

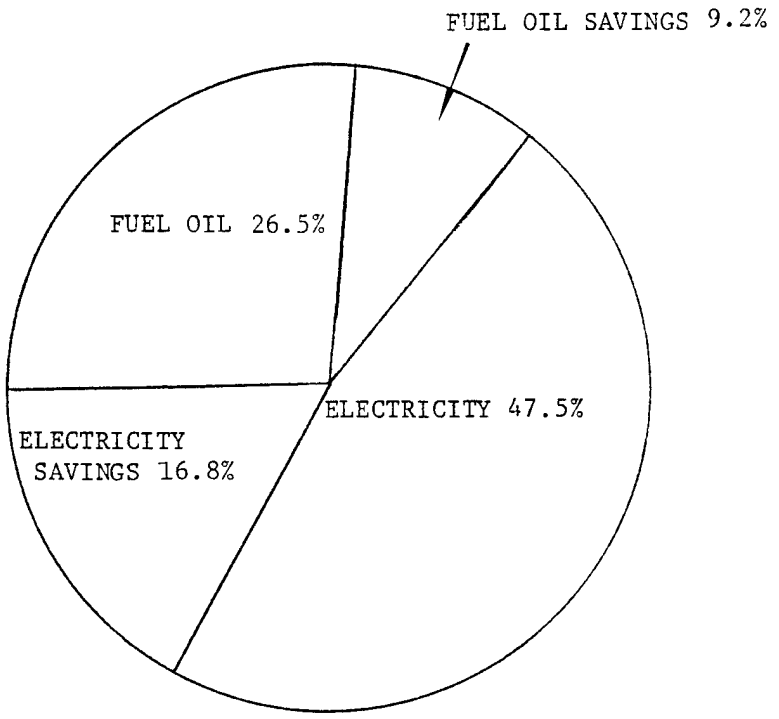
As can be seen in Table 9, none of the solar thermal or wind energy applications evaluated under either ECIP criteria or the guidelines in ETL 1110-3-332 for HDL achieved a savings to investment ratio (SIR) greater than 1. The highest SIR (0.83) was obtained for installation of the air preheat to the dry room in Building 204. This system had the lowest cost per square foot of any of the systems considered, primarily because no storage is required, however, solar air preheat was not cost effective becauase of the high efficiency of the heat recovery system currently in use.

The final results clearly indicate the potential for savings of over 29 percent in total energy use at the base by FY 1985, compared to the FY 1978 energy use baseline. Thus, the goals established in the Army Facilities Energy Plan should be exceeded by a comfortable margin. The magnitude of these potential savings is illustrated graphically in Figure 4, which should be compared with Figure 1 to gain an appreciation of the fuel oil and electricity savings that can be made.

TABLE 9. HDL INCREMENT C PROJECT SUMMARY

Site	Building No.	Group	Application	System Type	Collector Area (Solar) Rotor Dia. (Wind)	Existing Fuel	Solar Backup	% Solar	System Cost ($)	Discounted Energy Savings ($)	Total Discounted Saving ($)	SIR	Economic Life
Adelphi	204	R&D, office	Outside, air preheat	Solar, air type collectors no storage	1,056 sq. ft.	#2 oil	#2 oil	N/A	35,889 35,889	30,065 23,162	28,349 21,604	.79 .60	20 15
Wood-bridge	N/A	N/A	Electrical generation	50 kW 2 blade upwind with A.C. synchronous generator; pitch control		Elec-rticity	N/A	N/A	211,680	113,974	99,382	.47	25
Adelphi	202,203 204,205	R&D, office, service	Reheat & DHW	Two tank closed loop evacuated tube liquid	40,000 sq. ft.	#2 oil	Elec-tricity #2 oil #2 oil	15 15 15	2,359,054 2,359,054 2,359,054	-1,593,719 1,806,595 1,298,029	-1,843,537 1,556,777 1,183,124	<0 .66 .50	20 20 15
Wood-bridge	101	Office, R&D	DHW	Drain back, flat plate, liquid	40 sq. ft.	Elect.	Elect.	87	4,192	793	348	.08	20
	102	Office, Shop	DHW	Drain back, flat plate, liquid	40 sq. ft.	Elect.	Elect.	100	4,192	273	-172	<0	20
	103	Office, R&D	DHW	Drain back, flat plate, liquid	40 sq. ft.	Elect.	Elect.	71	4,192	1,180	735	.18	20
Adelphi	202	R&D, Office	DHW	Closed loop, flat plate, liquid	140 sq. ft.	#2 oil	Elect.	42	11,664	2,365	1,126	.10	20
	203	R&D, Office	DHW	Drain back, flat plate, liquid	80 sq. ft.	#2 oil	Elect.	59	5,040	1,592	1,062	.21	20
	204	R&D, Office	DHW	Closed loop, flat plate, liquid	140 sq. ft.	#2 oil	Elect.	42	11,644	2,364	1,126	.10	20
	205	Office Service	DHW	Closed loop, flat plate, liquid	140 sq. ft.	#2 oil	Elect.	26	11,644	1,231	-8	<0	20

Figure 4 goes here



TOTAL PROJECTED ENERGY USE FY 1985 – 344.339 Btu x 10^9 per year

TOTAL PROJECTED ENERGY SAVINGS BY FY 1985 OVER FY 1979 USAGE – 121.097 Btu x 10^9

TOTAL ENERGY SAVINGS MEASURED FROM FY 1978 BASELINE – 29.6%

NOTE: PERCENTAGES IN THIS FIGURE ARE DIRECTLY COMPARABLE WITH THOSE GIVEN IN FIGURE 1.

FIGURE 4. TOTAL PROJECTED FUEL USE AND SAVINGS, HARRY DIAMOND LABORATORIES (FY 1985)

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